HOUSE OF COMMONS SESSION 1996–97

SCIENCE AND TECHNOLOGY COMMITTEE

Third Report

THE NATURAL ENVIRONMENT RESEARCH COUNCIL AND RESEARCH INTO CLIMATE CHANGE

Volume I

Report, together with the
Proceedings of the Committee

Ordered by The House of Commons *to be printed*
12th March 1997

LONDON: THE STATIONERY OFFICE
£8·00

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Climatic changes - Research

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The Science and Technology Committee is appointed under Standing Order No 130 to examine the expenditure, administration and policy of the Office of Science and Technology and associated public bodies.

The Committee consists of 11 Members. It has a quorum of three.

The Committee has power:

(a) to send for persons, papers and records, to sit notwithstanding any adjournment of the House, to adjourn from place to place, and to report from time to time;

(b) to appoint specialist advisers either to supply information which is not readily available or to elucidate matters of complexity within the Committee's order of reference;

(c) to communicate to any other such committee and to the Committee of Public Accounts and to the Deregulation Committee its evidence and any other documents relating to matters of common interest; and

(d) to meet concurrently with any other such committee for the purposes of deliberating, taking evidence, or considering draft reports.

Unless the House otherwise orders, all Members nominated to the Committee continue to be members of it for the remainder of the Parliament.

The following were nominated Members of the Committee on 13 July 1992:

Mr Spencer Batiste
Dr Jeremy Bray
Mr Malcolm Bruce
Mrs Anne Campbell
Cheryl Gillan
Mr William Powell
Sir Giles Shaw
Sir Trevor Skeet
Dr Gavin Strang
Sir Gerard Vaughan
Dr Alan W Williams

Sir Giles Shaw was elected Chairman on 15 July 1992.

On 9 November 1992 Mr Malcolm Bruce was discharged and Mr Andrew Miller added to the Committee

On 16 November 1992 Dr Gavin Strang was discharged and Dr Lynne Jones added to the Committee.

On 7th November 1995 Cheryl Gillan and Mr William Powell were discharged and Mr Ian Bruce and Mr Patrick Thompson were added to the Committee.

The cost of printing and publishing this Volume is estimated by The Stationery Office Limited at £2,310.

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THIRD REPORT

THE NATURAL ENVIRONMENT RESEARCH COUNCIL AND RESEARCH INTO CLIMATE CHANGE

The Science and Technology Committee has agreed to the following Report:

1. On 22 May 1996 the Science and Technology Committee resolved to inquire into the Natural Environment Research Council (NERC), as the second inquiry that the Committee would conduct into a particular Research Council. The Committee's objective has been to combine an overview of the work of the Research Council in question with a more extensive examination of a particular topic. In the case of the Particle Physics and Astronomy Research Council, the Committee focused on the arrangements for funding international collaborative research through the international research organisations of the European Space Agency (ESA) and the European Laboratory for Nuclear Research (CERN).[1] In the case of NERC, the Committee decided to look at the arrangements for research into global climate change, a topic which also requires extensive collaboration within the international research community. This report is mainly concerned with research on global climate change, which accounts for only a quarter of NERC's portfolio. However, not only is the subject itself of intrinsic interest, but many of the factors which affect its success are common to other topics in the NERC portfolio and, in some cases, to the science base as a whole.

2. In the course of this inquiry we have received thirty eight submissions. We have also been able to draw upon the work of the Parliamentary Office of Science and Technology. We have held five sessions of oral evidence. In the first we took evidence from Professor John Krebs, Chief Executive of NERC, and other NERC officials. Subsequently we heard from Sir John Houghton, Chairman of the Royal Commission on Environmental Pollution; Dr Peter Cook, Director of the British Geological Survey; Professor Julian Hunt, Chief Executive, Dr Paul Mason, Chief Scientist and Dr David Carson, Director of the Hadley Centre, of the Meteorological Office; Dr David Fisk, the Chief Scientist at the Department of the Environment (DOE); Professor Brian Hoskins of the University of Reading; Professor Peter Liss and Dr Phillip Williamson of the University of East Anglia. We also visited the Southampton Oceanography Centre, which is jointly funded by the NERC and the University of Southampton.[2] We are very grateful to those who were involved in hosting that visit and all those who gave us evidence, both written and oral. In addition, we have been ably assisted by our Specialist Advisers, Professor Derek Burke and Sir Peter Swinnerton-Dyer; we very much appreciate their help.

GLOBAL CLIMATE CHANGE: BACKGROUND

3. Global climate change is part of a wider research topic, global environmental change. In this report we use the term Global Climate Change to cover research which relates directly to the climate itself, including research into topics such as ocean circulation; Global Environmental Change is used to indicate a far wider spectrum of research into the environmental implications or consequences of such change.

4. Some commentators doubt whether it has been proved that global climate change is happening, and argue that the observed changes can be explained by the short-term variability of the weather. But there is an overwhelming scientific consensus that climate change is occurring, that it is exacerbated by human actions, and that it will continue. We were told

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[1]Fourth Report from the Science and Technology Committee, Session 1995-96, *The Particle Physics and Astronomy Research Council*, HC 249-I.

[2]A note of this visit is attached at annex A.

that over this century the average global temperature had increased by 0.5°C.[3] This may seem a small amount, but the rate at which the increase has occurred is unprecedented. As Sir John Houghton, former Director General of the Met Office and Chairman of the Intergovernmental Panel on Climate Change (IPCC) Working Group on the Science of Climate Change, told us

> "if we carry on burning fossil fuels at the current accelerated rate...then the average temperature of the globe will go up by 2 or 3 degrees next century. That does not sound too much perhaps except when you realise that the difference between the middle of an Ice Age and the warm periods in between Ice Ages is only 5 or 6 degrees, so 2 or 3 degrees is about half an Ice Age in terms of the amount of change. And to do that in 100 years represents a very rapid change indeed."[4]

His Working Group warned

> "the balance of evidence suggests a discernible human influence on global climate."[5]

This conclusion was reached after an exhaustive peer reviewed survey of research into all the evidence, described below.

5. It would be reckless for policy makers to ignore such a consensus. The probability is that in years to come climate change will affect the ways in which we live more than any other single factor. Moreover even if tough international agreements on the emission of greenhouse gases were reached and implemented now, it is estimated that global warming would continue for at least a century; and at the end of that period the global temperature would only stabilise and would not revert to its earlier value.[6] To the extent that tough agreements are not reached, or are not fully implemented, the situation will become yet worse. The agreements on restraining the production of such greenhouse gases as CFCs appear to be being implemented; but there is cause to doubt that the production of CO_2 will be adequately restrained world-wide.

6. The first effects of climate change may well already be apparent. Almost all departments will have to grapple with the implications. The Department of the Environment is leading the way in international negotiations and in considering the implications of climate change for the country as a whole.[7] *Climate Change: the UK Programme* notes progress in reducing greenhouse gas emissions.[8] The Secretary of State hopes that the United Kingdom will do better than the Rio target of reducing to 1990 levels by 2000, and proposes that all developed countries should reduce to 5-10% below 1990 levels by 2010. The United Kingdom will already be well on the way to achieving that 2010 target by 2000.[9] Much of the reduction is coming from adapting to Combined Cycle Gas Turbine (CCGT)[10] for electricity generating. The Secretary of State also notes that we may well need to go further. That will be more difficult, making research of more critical importance.

7. For the Office of Science and Technology (OST), and for this Committee, the key issue is to ensure that research into climate change is properly organised and supported, and

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[3] Q339.
[4] Q124.
[5] *Climate Change 1995 - The Science of Climate Change, Summary for policymakers.* IPCC, p.10.
[6] *Climate Change 1995,* figs 7, 18, 19.
[7] Q253.
[8] *The Second Report under the Framework Convention on Climate Change,* Cm 3558.
[9] *Ibid,* p.2.
[10] *Ibid,* Para 2.11.

research results are disseminated to those who need them, including the Department of the Environment. To give one example of why more research is needed, there is general agreement that the change in temperature at particular times and places may be much larger than the change in the global average temperature. Nor is it only the direct effect on temperatures that matters; the most significant manifestation of global climate change is likely to be its effect on regional patterns of rainfall.[11] Unfortunately there is not yet enough agreement between those models which are detailed enough to provide climate predictions localised by place and season to allow any firm conclusions to be drawn. For example, although the *Review of the Potential Effects of Climate Change in the United Kingdom*[12] used a model that predicted increases in temperature over the next half century, there are those who suggest that climate change will lead to the cooling of North Western Europe as the Gulf Stream, which currently warms the air over Europe by about 5°C, changes course.[13] Research on local climate change is accordingly extremely important, and local and international studies can be inter-dependent.

International Research Into Global Climate Change

8. International research into global climate change and the related area of global environmental change is the province of a bewildering number of international organisations, and has been driven forward by an equally large number of international agreements. A full account is contained in *The Climate Agenda,* a proposal for integrating international research in Climate Related Programmes, drawn up by the Food and Agriculture Organisation, the International Council of Scientific Unions, UNESCO and the World Meteorological Organisation; what follows is a brief overview.[14]

9. Climate change research has both driven international environmental agreements and is driven by them. The United Nations held the first World Climate Conference in 1979. This led to the formation of the World Climate Programme (WCP) by the World Meteorological Organisation.[15] Research conducted under the auspices of WCP during the 1980s indicated that human activity was indeed capable of changing the global climate and the concerns so raised led to the establishment of the Intergovernmental Panel on Climate Change (IPCC) in 1988.

The IPCC

10. The role of the IPCC[16] is to assess and report on the research undertaken in this area, not to conduct research itself. It has three working groups, into "The Science of Climate Change", "Impacts, Adaptations and Mitigation of Climate Change" and the "Economic and Social Dimensions of Climate Change". The IPCC process is exhaustive:

> "Several hundred scientists came together to produce the various studies that form the chapters of the IPCC final report. Those were then sent out to many hundreds of other scientists for technical comment which you might consider to be a form of peer

[11] *Climate Change 1995,* Para F3.3.

[12] Second Report of the United Kingdom Climate Impacts Review Group, prepared at the Request of the Department of the Environment, HMSO, March 1996.

[13] Q49, *New Scientist,* 8 February 1997, p.26.

[14] Except where otherwise noted, all data are taken from *The Climate Agenda.*

[15] In conjunction with the UN Environment Programme and the International Council of Scientific Unions.

[16] Established by the United Nations Environment Programme and the World Meteorological Organisation to "assess available scientific information on climate change; assess the environmental and socio-economic impacts of climate change; and formulate response strategies."

review...the number of scientists that have been involved in expressing their ideas about the process really has soaked up all of the intelligent comment that could be made."[17]

11. Sir John Houghton told us that

"The IPCC has two great strengths which have contributed to its success. Firstly, we have involved a very wide range of scientists — over 90 per cent of the scientists who are actively working in the field in the world have been involved — so our reports are owned by the scientific community and that is absolutely essential if we are going to have scientific credibility. Secondly, because we are an intergovernmental body and because the Policymakers' Summaries are agreed at intergovernmental meetings, and the presentation of the science is something which governments have participated in, it is owned by governments, and because it is owned by governments, governments take it seriously and say, 'This is our report, so we have to work at it.'"[18]

The Rio Convention and other international agreements

12. The IPCC's work continues, but its first great influence was felt in the Framework Convention on Climate Change, drawn up in response to its findings and signed in Rio de Janeiro in 1992.[19] Article 2 of the Convention sets out its overall objective:

"stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. Such a level should be achieved within a time frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened and to enable economic development to proceed in a sustainable manner."

13. The uncertainties in the science of climate change mean that although some actions can already be recommended as useful, such as reducing carbon dioxide emissions wherever possible, a significant research effort will be needed to determine

— what level of greenhouse gas concentrations might meet the Convention's aims;

— what changes in food production might be necessary to ensure food security; and

— how economic development might proceed in a sustainable manner.

Many of these topics go wider than pure climate change research, but none can be successfully undertaken without more knowledge about the nature of climate change, both on a global and on a local level.

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[17]Q33.

[18]Q98.

[19]There are a number of other international agreements and projects on which research into global environmental change has a bearing; among them are:

- Agenda 21, the programme for sustainable development discussed at Rio;

- the International Convention to Combat Desertification;

- the Vienna Convention for the Protection of the Ozone Layer and its Montreal Protocol.

For further details see *The Climate Agenda.*

International Research Programmes

14. Although many other international organisations are involved in these and other programmes,[20] the World Meteorological Organisation (WMO) is the key influence on climate research and related activities; it is responsible for the World Climate Data and Monitoring Programme; the World Climate Applications and Services Programme; the World Climate Impact Assessment and Response Strategies Programme and, together with International Council of Science Unions and the IOC, the World Climate Research Programme. The main research programmes are summarised in Table 1. In addition to these international research programmes there are a large number of international programmes and organisations supplying the observational data on which research relies.[21]

Table 1

PROGRAMME	AIM
World Climate Research Programme (WCRP)(established 1980)	to develop the fundamental scientific understanding of the physical climate system and climate processes needed to determine to what extent climate can be predicted and the extent of man's influence on climate.[22]
International Geosphere-Biosphere Programme (IGBP)(established 1986)	to describe and understand the interactive physical, chemical and biological processes that regulate the total Earth system, the unique environment that it provides for life, the changes that are occurring in this system, and the manner in which they are influenced by human activities.[23]
Human Dimensions of Global Environmental Change Programme (HDP)(established 1990)	to describe and understand the human role in causing global change and the consequences of these changes for society.[24]

The Climate Agenda

15. The existing structure has produced some valuable research. The central costs are not excessive: $2 million per annum respectively for the WRCP and the IGBP, and $0.5 million for the HDP, which is less well developed[25], although host countries pay the costs of project offices. However, Professor Julian Hunt, the Chief Executive of the Met Office, drew attention to the incremental way in which these programmes had evolved, and the fact the work of different UN agencies might overlap, which meant that national governments were presented with multiple requests for funding programmes which appeared to have similar aims and had no clear way to decide between them.[26] In 1993 an inter-governmental meeting on the World Climate Programme called for

"the preparation of a document which comprised:

[20]Including the United Nations Environment Programme, the World Health Organisation, the Food and Agriculture Organisation and UNESCO.

[21]Including: World Weather Watch; Global Atmosphere Watch; Integrated Global Ocean Services System; Global Sea Level Observing System; Global Climate Observing System; Global Ocean Observing System; the International Council of Scientific Unions World Data Centres.

[22]P40.

[23]P41.

[24]P42.

[25]QQ361, 403.

[26]Q209.

—a critical review of current coordination mechanisms of international climate-related programmes;
—a proposal for the way forward covering:
—the required activities and management mechanisms;
—the associated costs."[27]

The Climate Agenda was drawn up in response and proposes a co-ordination mechanism which will enable interested parties to define their research needs and priorities and avoid duplication while building on existing programmes. It sets out international needs for climate research under four "thrusts," each with its own objectives and activities as shown in Table 2:

Table 2

THRUST	OBJECTIVES
New Frontiers in Climate Science and Prediction	ability to simulate past, present and future climates, including the influence of human activity, at those spatial and temporal scales of interest to governments.
Climate Services for Sustainable Development	introduction, on an operational basis, of information and predictions on climate, climate change and climate variability into socio-economic decision-making on a world wide basis.
Studies of Climate Impact Assessments and Response Strategies to Reduce Vulnerability	identify the means by which nations could reduce their vulnerability to climate, climate variability and both natural and anthropogenic climate change.
Dedicated Observations of the Climate System	provide on an operational basis those systematic observations of the climate system which will enable the preceding thrusts to meet the requirements of nations.[28]

16. The general strategy by which international climate change research has been guided is described in *The Climate Agenda* as

"based upon the voluntary contribution of nations in the form of research undertakings, technology such as satellites, observations and the intellectual capacity of their people to address the goals of a programme that they have all had the opportunity to help design...Under this strategy, the essential role of international programmes is to provide a framework whereby the contributions of nations can be focused towards shared goals."[29]

The Climate Agenda proposes a slight increase in and re-ordering of the co-ordination mechanisms for existing climate related research programmes; it does not suggest a wholesale change in the way in which they operate. These programmes generate a framework for world science; Dr Drewry, Director of Science and Technology at NERC, told us that "then it is up to national organisations like NERC to support programmes that are congruent and fit with some of those large headlines."[30] Scientists involved in research that falls into one of the

[27]P4.
[28]PP59-60.
[29]Para 2.2.
[30]Q38, see also Q312.

international programmes are likely to collaborate with colleagues from many different countries, each funded through the appropriate national research organisation.[31]

17. Although a system in which "the learned societies and the peer groups outline the programme but the funding is left to an uncontrollable process of independent agencies working nationally"[32] may appear chaotic, it is likely to be more effective in producing good science than any monolithic programme. In the course of this inquiry we had the opportunity to meet many people involved in such international programmes. We were impressed by all that they had achieved, and the way in which national programmes had been integrated into international projects. ***The Climate Agenda*** **says "The fundamental tenet of the WCP is that the climate problem is best addressed through the voluntary contributions of nations to international programmes which they have had the opportunity to design."[33] We agree that this method has been successful and should continue in future. We regard *The Climate Agenda* as the best available way of identifying priorities for future research, and we expect that it will indeed help international organisations to avoid duplication.**

Organisation of Global Environmental Research in the United Kingdom

18. It is difficult to quantify the total UK expenditure on global environmental research because of the range of topics it covers, and its close relationship with other research areas which means, for example, the same research can be applied both to climate change studies and to studies of coastal protection.[34] The best figures available are contained in the Report of the Expert Panel of the Inter-Agency Committee on Global Environmental Change.[35] These show that the major suppliers and funders of research into climate change itself are NERC, the Department of the Environment and the Met Office; other departments' expenditure is linked to the provision of multi-purpose satellites (BNSC[36]), or to research on the environmental effects of climate change. The three have interlinked, but essentially complementary, roles; NERC provides basic research; the DOE funds research intended to aid it in forming policy; and the Met Office's primary role is to forecast the weather.

NERC

19. Global environmental research includes much research which is properly the responsibility of Research Councils other than NERC; for example, the MRC currently conducts research on the impact of tropospheric pollution in health, and the BBSRC into plant acclimatisation to environmental stress. Nonetheless, NERC is by far the biggest funder of research in this field; its total spend on global environmental research was some £40m in 1995-96, compared to £6.7m for all other Research Councils' work on the topic.[37] It is also the Research Council with direct responsibility for work on climate change.

20. Some 27.5 per cent of NERC's funding is allocated to global environmental change and the topic covers work in many different fields.[38] A summary of its activities is contained in Table 3 and in addition, many of the long term data sets held by NERC are extremely valuable for research into climate change. NERC told us that as far as international programmes were concerned,

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[31]Q361.

[32]Q40.

[33]Para 6.1.2.

[34]Q276, QQ316-318, QQ371-372, Ev. (Vol II), p.103.

[35]*UK National Strategy for Global Environmental Research,* 1996 (Hereafter Expert Panel Report).

[36]British National Space Centre.

[37]Expert Panel Report, pp.28-29.

[38]Ev. (Vol II), p.3.

"The UK has strong, yet selective, involvement in the scientific leadership and implementation of these programmes. In the UK the case for support of national programme contributions is always considered alongside other claims against the research budget, and takes account of the quality of the science and the capability of the UK to make a significant contribution."[39]

Table 3

NERC RESEARCH RELEVANT TO GLOBAL ENVIRONMENTAL CHANGE
Processes within and between the atmosphere, ocean, sea ice, terrestrial systems, (including clouds, fluxes of energy, nutrients and gases). Earth radiation budget studies. Spatial and temporal variability.
Observational and modelling studies to improve and quantify understanding of the primary sources, chemical interactions and transport of gases and particulates in the troposphere.
Influence of polar regions on global systems and their response to environmental change.
Integrated atmospheric, hydrological and biological modelling of impacts on land surfaces.
Impacts of climate change, increased UVB radiation and atmospheric pollution on ecosystems.
Factors controlling the origins, maintenance and loss of biological diversity and how changes affect ecosystem processes; factors influencing distribution and abundance of organisms and community assembly; role of habitat in maintaining diversity.[40]

The Department of the Environment

21. The Department of the Environment has lead responsibility in international negotiations about climate change, and the measures which should be taken to alleviate its consequences. It also takes the lead in forming national policy on this issue and has been effective in both these arenas. It needs to fund research to enable it to form its policies.[41]

22. At present the main centre of Department of the Environment climate change research is the Hadley Centre which is located within the Met Office. The Hadley Centre's task is to provide a computer model of climate change; its staff work closely with the Met Office to do so, and the Hadley Centre model is believed to be among the best in the world, in part because of its close relationship with the day to day practicalities of weather-forecasting.[42] Although the Hadley Centre is so respected, the Department's main aim is to underpin its own policy responsibilities; the Chief Scientist made it clear that if the most advanced models were available outside the United Kingdom his priority would be to buy access to them rather than to fund British researchers to replicate that work.[43] But although research on global climate change is world-wide, it is only in the United Kingdom that research on local climate change in the United Kingdom is likely to be a priority.

The Met Office

23. The Met Office, now a trading fund, is part of the Ministry of Defence and the Ministry of Defence remains one of its principal customers. It funds a relatively small amount of high

[39]Ev. p.27.
[40]Expert Panel Report, p.28.
[41]Ev. (Vol II), p.68, Q52.
[42]Ev. (Vol II), p.128, Q252.
[43]QQ252, 254.

quality research to underpin its forecasting activities, which is of immediate relevance to climate research. In addition, the Met Office places some research contracts with NERC, and carries out some research in collaboration with the Research Council. The Met Office runs the United Kingdom's only dedicated research flight, a converted C-130 aircraft which is heavily instrumented. Some of these instruments were provided and paid for by NERC.[44] The flight is currently under threat for financial reasons; we return to this issue below.

24. Dr David Fisk, Chief Scientist of the Department of the Environment defended the division of responsibility — NERC - underpinning research; Department of the Environment - funding research into anthropogenic climate change; and Met Office - weather forecasting — on the grounds that "science that is championed by people who are going to use it is always much more effective" than research carried out more generally.[45] Certainly the Department of the Environment, NERC and the Met Office have worked together extremely efficiently in the past. The United Kingdom has been extremely effective in international negotiations: NERC, the Met Office and the Department of the Environment each independently referred to steps taken to co-ordinate the United Kingdom's stance.[46] Still more significantly the United Kingdom's research in this field does not seem to have been harmed by the system. Sir John Houghton told us that

> "We are very clearly second to the US in the quantity of research, and we are equal to the US in the quality of research."[47]

In the last four years three Craaford prizes, the equivalent of Nobel prizes for the environmental sciences, have been awarded to British scientists[48] and Sir John's position as the Chairman of IPCC Working Group One, Professor Hunt's ability to drive *The Climate Agenda* and Professor Liss's Chairmanship of the Scientific Committee of the IGBP also attest to the high international standing of United Kingdom scientists in this field. **We congratulate those responsible for ensuring that climate change research in Britain has been so successful and has been handled so effectively.**

25. Past success, however, may lead to complacency: there are a number of matters which will need attention if this success is to continue. They can be summarised as the mechanism for co-ordination of research in future; pressures on NERC and the Met Office to move their research closer to the market; financial pressures; and the impact of departmental policies on global environmental research and on NERC's wider responsibilities.

Threats To Future Success

Co-ordination of Departmental Responsibilities

26. Co-ordination of the many parties involved in research in global environmental change takes place at many levels. There are strong links between researchers in the Met Office, in NERC and in universities. The Research Councils have jointly established a UK Global Environment Research Office "to act as a focal point for the flow and exchange of information."[49] Among its other activities, the Office produces a regular newsletter "The Globe" which disseminates national and international research opportunities. However, at the highest level co-ordination is undertaken by the Inter-Agency Committee on Global

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[44]Ev. (Vol II), p.128.
[45]Q268.
[46]QQ36, 214, 266.
[47]Q133, see also Q383.
[48]Q4.
[49]POST note.

Environmental Change (IACGEC), which contains the Chief Executives of the Research Councils, and of the Met Office, the Director General of the BNSC, and the Chief Scientist of the Department of the Environment. Until July 1996 it was under the Chairmanship of Professor Sir Ronald Oxburgh, Rector of Imperial College. No new Chairman has yet been appointed, since the Committee is under review.[50] IACGEC was not an expert body, but commissioned work from expert groups when necessary.[51]

27. There was concern that the Inter-Agency Committee on Global Environmental Change appeared to have ceased to function, without any indication that a successor body would be appointed. Currently the OST is

> "in the process of reviewing its past performance and the possible future role and structure for a successor body."[52]

Many observers have noted, in many different contexts, that there is an inherent difficulty in dealing with multi or inter-disciplinary research topics which do not fall neatly within the bounds of a single Research Council. As Professor Liss said "global change is much more than just climate change"[53]; not only does it affect almost all the Research Councils[54] but many Government departments have, or should have, an interest in it. Some co-ordinating method is essential.

28. *The Climate Agenda* suggests that countries should "establish national climate programmes to provide a mechanism which could be used to coordinate:

> —national climate related activities;
>
> —allocation of national priorities;
>
> —reporting to the bodies responsible for the management of *The Climate Agenda.*"[55]

It seems unlikely that the United Kingdom will establish a single climate change programme since the existing structures have served the subject well, but there are a number of co-ordination tasks which need to be performed:

> —ensuring that all departments are aware of the latest research on global change, and the policy implications of that research;
>
> —ensuring that research into global warming in the United Kingdom is well organised and research topics are not needlessly duplicated or neglected because of the patchwork of departmental responsibilities;
>
> —ensuring that appropriate resources are devoted to global environmental research.

The first of these is carried out by the Department of the Environment, and its annual reports on *Climate Change: The UK Programme,* and the report on *Potential Effects of Climate Change in the United Kingdom* show an impressive dedication to the task. The Government Panel on Sustainable Development also does valuable work in this area, although its remit is,

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[50]Ev. (Vol II), p.129.
[51]Q269.
[52]Ev. (Vol II), p.129.
[53]Q396.
[54]With the possible exception of PPARC and the CCLRC.
[55]PP.102-103.

of course, far wider than global environmental change alone. The second task could, in principle, be conducted at a relatively low level and might benefit from such co-ordination. The Expert Group of the IACGEC noted that

> "there is no single national group or committee with responsibility to:
>
> —Oversee GER coordination between research groups with different disciplinary backgrounds.
>
> —Stimulate the development of new contacts and interactive research initiatives.
>
> —Carry forward the policy review initiatives of the IACGEC on an inter-agency basis; for example, through multi-disciplinary workshop meetings on interactive and integrative research topics.[56]

However, the third task requires the involvement of senior officials, who have, when necessary, ready access to Ministers. Moreover the tasks are interdependent, and the allocation of resources may involve complex judgements which require knowledge across all these fields.

29. For example, in considering the expenditure needed for global environmental research it will be important to ensure that existing resources are used to the full; the Expert Group noted

> "Under existing arrangements, there is a real risk that the synergistic benefits that may be derived from special programmes, and the potential value of many data-gathering exercises, will not be fully exploited by the scientific community, and hence will not become available to research users."[57]

This is a problem in which national and international considerations need to be considered together. One of the four "thrusts" of *The Climate Agenda* is Dedicated Observations of the Climate and the document calls for an increase in the observations available to the world community, which would entail significant investment in satellites.[58] This was supported by Sir John Houghton, but the Chief Executive of the Met Office felt that existing data were not always used to its full, and that co-ordination was needed to ensure that all possible users were aware of its potential.[59] Insofar as this is a United Kingdom problem, Professor Hunt told us he was "confident that promotional efforts will result in many of these opportunities being taken up."[60] However, Dr Fisk noted that although

> "Professor Hunt must be right to say that the international community has not fully grasped the need to have its present data sets widely available and widely used...there are some long-term difficult problems on quite large scales of funding which the international community has yet to complete its deliberations, which I think Sir John [Houghton] is quite right to signal are coming our way."[61]

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[56]Expert Panel Report, p.30.

[57]P30.

[58]Section 5, especially para 5.5.4.

[59]QQ237-238, see also QQ328, 335.

[60]Ev. (Vol II), p.63.

[61]Q280.

The number and type of observation systems available globally are likely to have resource implications for the United Kingdom, and any body which seeks to co-ordinate national research into environmental change will need to be aware of these issues.

30. Professor Liss, a member of the Expert Group, suggested that the United Kingdom should have a two tier system, in which co-ordination at the science level was undertaken by three committees of researchers, each corresponding to one of the three major international programmes

> "The point of those groups would be for scientists to decide what should be the UK's emphasis from a scientific perspective, ie, there is a huge amount of research being done internationally and the UK clearly cannot participate in all of it and we should not try to do so. So...where should we advise those who have the money to put it?"[62]

Above them should be a high level body, something like the IACGEC,

> "which receives the scientific input from the subsidiary bodies and maybe has...the chairmen of these bodies as members, but also must contain those people who more directly control the funds, eg the Chief Executives of Research Councils, Chief Scientific Advisers to the relevant government departments, et cetera. Because they are the people who can make it happen."[63]

Dr Fisk felt that the IACGEC had been effective, and the one change necessary would be to ensure that government departments with a direct interest in climate change should be represented, rather than that the Department of the Environment should continue to represent the interests of all government departments.[64]

31. **There is much merit in devolving the choice of topics to the researchers best placed to make them, and we endorse the principle that research programmes should be driven by peer review rather than centrally directed by government.** As Professor Hoskins, the Chairman of the Expert Panel said, "Let the scientists push on it and the Research Councils will respond."[65] However, given the pressure on Whitehall, there may be a temptation to establish co-ordination only at the level of active researchers, and to have little high level involvement. As we discuss below, some of the problems facing environmental research can only be solved if political decisions are taken. There is a need for a voice at the highest levels to ensure that departments and ministers do not overlook the challenge that environmental change will face them with, or inappropriately reduce the resources devoted to research and policy formation designed to alleviate its effects. For such advice to be effective, it will need to be informed. **We also recommend that whatever co-ordinating mechanisms are established for research into global environmental change, among them should be a successor body to the IACGEC in which the Chief Scientific Adviser, the Heads of the Research Councils, the Chief Scientists of relevant departments and independent members from industry are represented.**

[62] Q397.
[63] Q397, see also Q269, Q273.
[64] QQ269, 273.
[65] Q301.

Pressure to move closer to the market

32. Some witnesses expressed concern that basic research was being undervalued as the result of pressure on NERC and on the Met Office to move closer to the market.[66] The issues are rather different in each organisation and are best discussed separately.

The Met Office

33. Since it became a Trading Fund in April 1996, the Met Office's research programme has had to be funded through the income generated by selling its services to a range of public service and other customers. Some witnesses were concerned that this would reduce its ability to fund research,[67] and Professor Krebs told us

> "whether the research shifts to more near-market remains to be seen. I have certainly been very aware of that possibility and have been in discussion with Julian Hunt about the possible responsibility that would fall on to NERC's shoulders if indeed the Met Office did move away from more basic underpinning research, and I have argued that if we were to accept that responsibility we would welcome it, but it would require some additional resources."[68]

34. The Met Office's success has, in part, rested on its scientific status. There is no reason why moving to a Trading Fund should damage the Office's ability to fund basic research, but the precedents are not good. The Rothschild principle under which research funds were transferred from Research Councils to Departments so that they could define and purchase the research they needed resulted in a diminution of research funding, and many departments appear not to have paid the 10 per cent research overhead recommended by Rothschild.[69] **We recommend that the Met Office's ability to run a high quality research programme be kept under review by the successors to this Committee and to the Defence Committee.**

35. A new Chief Executive for the Met Office is shortly to be appointed. Hitherto, Chief Executives have taken leading roles in international discussions of climate change. Sir John Houghton, the previous Chief Executive, is a leading figure in the IPCC; the current incumbent, Professor Hunt, has been a key figure in introducing *The Climate Agenda*.[70] **The United Kingdom's influence in discussions of climate change is vastly enhanced by the fact that the Chief Executive of the Met Office is a scientist of international standing, as Professor Hunt and his predecessors have been. Professor Hunt's successor is shortly to be chosen; in our view it is essential that whoever is given the post should also satisfy this criterion.**

NERC

36. Some of those who submitted evidence considered that, both in global change research and in NERC's research portfolio as a whole, the Council was inclined to stress the responsibility for "wealth creation" given by its mission statement at the expense of its responsibility for "quality of life" also set out in its mission statement, and that support for basic research had declined and would decline in future.[71] As far as global change was

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[66]See, for example, QQ321-323, QQ349-357, Q362, Ev (Vol II), pp.85, 104, 108, 109, 121.

[67]Ev. (Vol II), pp.110, 113.

[68]Q63.

[69]Second Report from the House of Lords Science and Technology Committee, Session 1993-94, *Priorities for the Science Base*, HL 12-I, para 2.37.

[70]Q209.

[71]See Ev. (Vol II), pp.85, 104, Q234.

concerned, there was general agreement that NERC's role should be to provide basic research. The Chief Executive of the Met Office maintained

> "it is very important for a research organisation not to be...excessively goal orientated. It should be able to look at all sorts of possibilities.[72]

37. NERC's role, of course, goes far wider than that of global climate change.[73] Its mission is to contribute to the "knowledge, understanding and prediction of the environment and its resources."[74] Although this includes research into global climate change, it goes far wider; NERC's portfolio identifies six Environmental and Natural Resource Issues — biodiversity; environmental risks and hazards; global change; natural resources; pollution; and waste.[75] The resources that NERC devotes to research into global change can only be decided in conjunction with its other research priorities.

38. The Research Council has certainly made great efforts to apply the White Paper principles that its research should be relevant to the user community, tracing the research it funds against the priorities identified in the Technology Foresight exercise.[76] It has also introduced a new funding model which distinguishes between four modes of funding:

> "Core strategic" — this is intended to maintain expertise and knowledge in key areas; it is particularly long-term and supports research, survey and monitoring, technology development and the curation, interpretation and supply of environmental data. It can be thought of as the maintenance of "core skills."
>
> "Thematic" — this covers a wide field. The Council defines "themes" — broad research topics, such as Environmental Diagnostics or Urban Regeneration and the Environment — in its strategic planning, which includes inputs from Technology Foresight. Researchers are then free to propose projects that fall within these themes, which could, in principle, be basic science, strategic or applied science, although in practice some themes are more narrowly drawn than others. In addition thematic funding supports technology development and training within the selected themes.
>
> "Non-thematic funding" — this covers areas of curiosity driven research, training and technology development chosen by applicants without any guidance such as that provided by the thematic priorities.
>
> "Infrastructure funding".[77]

39. NERC itself distinguished between the OECD Frascati categories[78] of "pure basic" (advancement of knowledge without working for long term economic or social benefits) and "oriented basic" (carried out with the expectation the knowledge produced is likely to form the background to the solution of current or future problems) and maintained:

> "As a mission based Research Council we have taken the view that the proportion of "pure basic" research that we support will be limited and that much of our basic research

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[72]Q218, see also Q322.

[73]The Parliamentary Office of Science and Technology (POST) prepared us a background briefing note outlining NERC's research portfolio and other relevant issues.

[74]Ev. (Vol II), p.1.

[75]Ev. (Vol II), p.3.

[76]*Ibid.*

[77]Based upon Ev. (Vol II), pp.2-3.

[78]By which research is classified so that international comparisons can be drawn.

falls into the "basic oriented" category. With this in mind we do distinguish between support given in the purely responsive "non-thematic" mode and that where proposals are invited against themes — "thematic" and "core strategic modes."[79]

"NERC support given to non-thematic 'curiosity driven' research currently represents 20 per cent of the Science Budget. ...it is unlikely that [Council] would wish to see it diminished. There is also basic research done under the thematic and core strategic modes."[80]

40. The research community has some grounds for its concern about NERC's commitment to basic research. Last year there was a decline in the proportion of NERC's science budget devoted to non-thematic funding,[81] and funding for natural resources and global change will be reduced while research into waste, a topic clearly industrially applicable, will be increased.[82] £400,000 was set aside for "Connect", a new scheme to promote partnerships between the science base and industry, business and commerce, in 1995-96 and £750,000 per year will be devoted to it until 1998.[83] As NERC itself points out, OST initiatives, such as Realising Our Potential Awards and Foresight Challenge, have reduced the flexibility available to the Council.[84] However, it is also important to note that NERC defines its programme in terms of key Scientific Challenges for the next 5 to 10 years, as well as in terms of user group needs.[85] The decline in responsive research is likely to be reversed, and the reduction in NERC expenditure on global change is influenced by the ending of several major programmes and "does not take account of the at present unpredictable future allocation of the headroom that will be created over the same five years for new initiatives."[86]

41. Technology Foresight and the White Paper objectives are not necessarily incompatible with basic research. We endorse the White Paper principle that Research Councils should consider the users of their research in drawing up their programmes. However, this does not mean they should take a short term view, or confine themselves to topics which current users can identify. Their primary responsibility must be to ensure the health of the science base and the continuation of the long term basic and strategic research which only government will fund. It is very important that all parties recognise that such research is essential to ensure both our future quality of life, and our future prosperity. Global environmental change is a prime example of a topic which will clearly affect our quality of life. But it would be wrong to think of it in those terms alone; the *Review of the Potential Effects of Climate Change in the United Kingdom*[87] considers the implications for many industries, including the manufacturing, retailing and service industries, insurance and the financial sector. **From the evidence available to us at this stage, NERC's approach seems entirely reasonable; much**

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[79]Ev. (Vol II), p.2.

[80]Ev. p.2.

[81]Ev. (Vol II), p.131.

[82]Ev. (Vol II), p.6.

[83]Annual Report 1995-96, p.25.

[84]Ev. (Vol II), p.1.

[85]These are:

— Characteristics of the atmosphere;
— Data from satellites;
— Dynamics of the Earth;
— Evolution, biodiversity and ecological roles;
— Fluid flow through rocks and soils;
— Global biogeochemical cycles;
— Impacts of environmental change and stress;
— Oceans, atmosphere and ice;
— Past environmental change;
— Population change and persistence. *Forward Look of Government-funded SET 1996*, Cm 3257-I, p.133.

[86]Ev. (Vol II), p.6.

[87]Prepared at the request of the Department of the Environment by the Climate Change Impacts Review Group, HMSO, March 1996.

will depend on the extent to which new initiatives which the Research Council chooses to fund in future recognise its responsibility for basic research. We are encouraged by the high level of support for research into climate change. The level of that support may fluctuate as large projects are completed or introduced, but we recommend that it remains a top priority.

Pressures on NERC Funding

42. NERC's budget has varied over the last decade, and is projected to vary in the future as follows:

NERC budget in real terms (£million) (1994-95 base year)

1986-87	1987-88	1988-89	1989-90	1990-91	1991-92	1992-93	1993-94	1994-95
105.9	104.8	123.1	143.9	156.8	133.8	136.0	142.9	146.1

Projected Figures

1995-96	1996-97	1997-98	1998-99	1999-2000
151.6	156.7	154.0	154.7	150.9[88]

The increases in funding between 1988 and 1991 are largely due to the extra funding required to construct the Southampton Oceanographic Centre, and for the first phase of the World Ocean Circulation Experiment. Some of the increase in 1994 is due to the transfer of responsibility for earth observation to NERC at the time of the 1993 White Paper. The real terms decrease projected for 1999-2000 is common to all Research Councils. **We have already made clear our view that the Science Budget should be increased;[89] we hope that the decreases projected for the future will not in fact materialise.**

The Research Vessels

43. Climate change research requires access to expensive facilities, such as the C-130 research flight, discussed below, and research vessels. NERC has three research vessels, the RRS Discovery, RRS Charles Darwin and the RRS Challenger, in addition to the vessels which support the British Antarctic Survey. Many witnesses expressed concern that these expensive assets were not being used to the full, and attributed this to NERC's introduction of a system in which the costs of ship time were included in grant applications.[90] Their fear was that this inflated the costs of such research and discouraged grants committees from supporting proposals which required ship time rather than other, cheaper, projects. The baseline costs of the vessels, even when they are unused in dock, is far greater than the marginal cost of their use for research. NERC has taken a decision not to fully fund the costs of the research fleet, since other projects were of higher priority.[91] As Dr Drewry said

> "a vessel can be at sea for 90 per cent of the year and it has to be in dock being scraped down and cleaned up for 10 per cent. We are actually able to deploy the vessels for 70 per cent of the time because we do not have enough money to pay for the other 20 per cent."[92]

[88]Source: SET Statistics 1996; Allocation of Science Budget and House of Commons Library.

[89]Fourth Report from the Science and Technology Committee, Session 1995-96, *The Particle Physics and Astronomy Research Council,* HC 249-I, para 102.

[90]Ev. (Vol II), pp.107, 114, 125.

[91]Q97.

[92]Q93.

Professor Krebs added that the Director of the Research Vessel Service had been asked to provide extra funds for science by chartering the ships commercially for part of the time that could not currently be used.[93] It is always difficult to balance the costs of not using an expensive piece of equipment to its full against the extra costs that will be incurred in its use, including the cost of other research projects foregone. While we appreciate the frustration of researchers, NERC's system for allocating time on the vessels is a reasonable one, and the Council is attempting to increase funding and so increase the ship time available.

44. There are also likely to be longer term problems in providing large scale facilities. NERC told us

> "We are aware that provision of such facilities is not viewed with favour within OST and that top-slicing of the Science Budget will no longer be an option. This, together with the reduction in internal flexibility, means that it is difficult to see how future provision will be managed."[94]

In the past, it was possible to provide capital for developments such as the Southampton Oceanography Centre. In the latter case that capital has enabled the United Kingdom to establish a centre which we expect to be a world leader in its field.[95] We trust it will be possible to make such investments in future. **We recommend that our successor Committee keeps the extent to which Research Councils are able to invest in major capital facilities under review.**

45. In addition to problems in funding equipment and research that fall wholly within its remit, there appears to be a danger that NERC will in future be expected to cover costs that currently fall to other departments. We have already noted the possibility that the conversion of the Met Office to a trading fund would increase pressure on NERC. In the course of our inquiry we discovered two other cases in which increased pressure on the NERC budget appeared to be likely; attribution of contributions to the EU research budget and the use of the C-130 aircraft.

Attribution

46. The United Kingdom's contribution to European Union funds above a certain baseline is attributed to the baselines of various government departments at the beginning of the PES round; it appears that an increase in European Union spending in one area may lead to a decline in the amount of money the department has available to dispose of as it pleases. However, as the OST told us last year:

> "Attribution of the cost to the UK of EC R&D programmes is calculated each year on the basis of policy responsibility and is one of the inputs to the annual Public Expenditure Survey. This arrangement allows for EC expenditure on R&D to be taken into account in the expenditure discussions; but, because attribution is an input, not an adjustment made at the end of the Survey, there is no way of determining precisely its effect on the final provision for domestic S&T."[96]

47. In the course of this inquiry we asked whether there had been any pressure to transfer expenditure attributed to other government departments to the OST. NERC told us:

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[93]Q94.

[94]Ev. (Vol II), p.1.

[95]Q82, see Annex.

[96]Quoted in the First Report from the Science and Technology Committee, Session 1995-96, *Technology Foresight*, HC 49, para 98.

> "There was a very major shift in attributions last year for the Environment and Climate programme between OST and DOE, with OST accepting a fourfold increase from 7.6% to 28%. There was also a DOE to OST shift of 7.5% within the Marine Science and Technology programme.
>
> Discussions on proposals from DOE to further increase the OST share of the Environment and Climate programme are still in progress. The proposal is being resisted in the light of the major rebalancing agreed last year.
>
> At present it is correct to say that attribution is borne at the level of the OST as a whole."[97]

As far as outsiders are concerned, the Public Expenditure Survey is a complex and subtle process, in which it is impossible to relate inputs to outputs, nor is it possible to relate transfers at OST level with the actual allocation to individual Research Councils. Nonetheless, in practice, we fear that the effect of this transfer of attribution will be to reduce the resources available to all the Research Councils for the support of pure and strategic research, even though the EU programmes which are the excuse for this attribution are largely composed of applied research.

48. **We are concerned that changes in the attribution of European Union funding may reduce the Science Budget by stealth; the implications of the transfer of attribution to the OST should be acknowledged openly and in detail. In 1995-96 we won an undertaking from the Government that figures for the distribution of attribution between Government departments would be published in the Forward Look:[98] we urge our successors to keep these figures under review.**

The Research Flight

49. The Met Office operates a C-130 aircraft that has been converted to carry instrumentation. NERC has had access to the flight since 1991, and has provided some of the instrumentation it carries.[99] In the course of this inquiry we became aware that the funding for the Research Flight had been reduced, as the MoD did not consider its costs justified its scientific value to the Met Office.[100] The Met Office is to attempt to keep the Research Flight in being by charging flying time to other users, including other European countries and the European Union itself. If not, we were told that the Met Office would buy time on another aircraft to make the observations it needed.[101]

50. There is indeed sense in seeking some of the funding for this facility at the European level, and we hope the Met Office will be successful in this. However, although the MoD's decision is rational at the departmental level, we are not sure it is in the best interests of the country as a whole. If attempts to keep the Research Flight fail, it is hard to see precisely where the Met Office will find alternative facilities at a lower cost; both NERC and the Met Office agree that the C-130 is the only flight of its calibre in Europe, and its quality has encouraged the US to send its research planes to engage in collaborative research.[102] Even if the Research Flight can be maintained, the amount available to spend on research in the

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[97]Ev. (Vol II), p.130.

[98]*Technology Foresight: Government Response to the First Report of the Select Committee on Science and Technology,* Session 1994-95, Cm 3224, para 33.

[99]Ev. (Vol II), pp. 127-28.

[100]Ev (Vol II), p.130.

[101]Q232.

[102]Ev. (Vol II), pp.127-28, 130.

United Kingdom will be diminished as NERC will now have to find fees for air time of £6,000 per hour, before VAT. Before 1995 the flight was free and in 1995-96 charges were £2,000 per hour.[103] NERC estimated that if research proposals rated alpha-4 and above were funded, demand might "exceed £850,000 in 1997-98 alone."[104]

51. The Research Flight is a key tool for atmospheric chemistry, which currently constitutes the biggest uncertainty in our understanding of global climate change. Threats to the flight are doubly unfortunate since funding for this subject already appears to have suffered from the division of responsibilities between NERC and the Met Office.[105] Many witnesses were concerned that support for atmospheric chemistry would decrease, partly as a result of the Met Office's transformation into a Trading Fund and partly as a result of reductions in NERC expenditure on the subject.[106] Some concern may be misplaced. Professor Krebs told us that although two major atmospheric science programmes were due to end in 1998 and 1999, which meant that projected funding for the subject appeared to fall, "We are expecting the atmospheric science community to propose new programmes".[107] NERC is also seeking new co-ordination mechanisms for the subject.[108] It is clear, however, that the research community is uneasy and Professor Krebs himself warned that the new mechanisms for dealing with the Research Flight meant that "it is possible...that the UK core capacity in atmospheric science will decline over the next five years."[109]

52. **The fact that the UK has no separation of civilian and military forecasting services has prevented costly duplication; it would be unfortunate if the combination of services now meant that the resources available for meteorological science were further reduced in real terms.**

53. There is a possibility that NERC's budget will come under pressure from other factors apart from shifts in attribution or the increasing cost of the C-130 flight. Discussions are taking place within the British National Space Centre on the future funding of the UK Earth Observation Programme[110]; as Professor Krebs said "if there is any intention that NERC should, for example, assist in supporting the European Space Agency Earth Observation programme...this would be a new development with substantial funding implications."[111] **It is easy for each department to pursue the course which will increase its ability to concentrate upon functions it regards as its core, and maximise the resources it can devote to that core. The Government as a whole must be aware of the danger that even though the headline figure of the Science Budget may remain stable, a wider range of responsibilities will mean that it is spread more thinly and less effectively.**[112]

The Indirect Effects of Departmental Policies

54. Policy decisions in seemingly non-scientific areas may also adversely affect the science base. The example we received in the course of this inquiry was the effect of DTI procurement policy on the British Geological Survey's data sets.

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[103] Ev. (Vol II), p.128.
[104] *Ibid.*
[105] QQ389-392, Ev. (Vol II), pp.111, 113.
[106] Ev. (Vol II), pp.104, 106, 110, 111, 113.
[107] Q64.
[108] QQ62-64.
[109] Ev. (Vol II), p.128.
[110] Ev. (Vol II), p.2.
[111] Ev. (Vol II), p.130.
[112] See QQ345-347.

55. As the 1995-96 NERC Annual Report says, "data are the lifeblood of scientific research and the foundation on which effective protection and management of the environment and its resources are built."[113] NERC has seven data centres,[114] and a considerable amount is spent on them; the National Geosciences Information Service (NGIS), run by the British Geological Survey (BGS), costs over £2 million per year. NERC is making investments to ensure that these data are "better managed, integrated and publicised, to be more readily accessible to a wider range of users, and to be easier to use."[115]

56. A significant amount of the data held by NERC comes from the private sector or from other government departments. We were disturbed to hear that changes in DTI hydrocarbon commissions with the BGS had led to fragmentation of hydrocarbon data, "impacting on NERC's capability to act as a repository for national data in this field."[116] Before services were market tested in 1993 the BGS managed the DTI core store which contained data from boreholes sunk by oil and gas companies, which the companies were obliged to supply to the DTI. Once the data had ceased to be confidential they were passed to the NGIS in a form compatible with its databases. Since then the contract has been split into five different contracts, each awarded to a different bidder; the BGS retained the contract for geological advice, but other contracts, including those for core analysis and core storage were awarded elsewhere. There is a legal requirement for data from onshore boreholes to be logged with BGS. However, there is no such requirement for offshore data, and the DTI's decision has reduced the coverage of the NGIS.[117]

57. The DTI told us that when BGS operated the core store for the DTI only staff working on DTI contracts could use the information until it was released from confidentiality[118] and argued that although BGS scientists previously had pre-sight of information the "availability of hydrocarbon data to other parts of BGS has never been the norm."[119] Furthermore the department contended that BGS "was a competitor in the oil and gas consultant market and that DTI should not favour one consultant over another by allowing BGS unfettered access to data less than 5 years old."[120]

58. The role of the NGIS is distinct from those parts of the BGS which tender for commercial contracts and we were told that many private companies were happy to lodge confidential data with the NGIS.[121] The DTI's contention that data could best be protected by being held in a number of different localities ignores the added value which may accrue from combining data from different sources, and the difficulties of combining databases which have been constructed in different ways. Furthermore, as Dr Cook, the Director of the BGS told us:

> "if a company goes out of business there is no reason for it to hand on its data to anybody else at that stage...this information is very, very valuable for a long, long time; longer than the oil companies are going to be around. We have to regard it as a national asset and it has to be curated and kept with that in mind."[122]

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[113] P29.

[114] Antarctic Environmental Data Centre; British Atmospheric Data Centre; British Oceanographic Data Centre; Environmental Information Centre; National Geosciences Information Centre; National Water Archive; NERC Scientific Services Data Centre.

[115] Annual Report 1995-96, p.30.

[116] Ev. (Vol II), p.1.

[117] Ev. (Vol II) pp.28, 131-32, see also Q201.

[118] Ev. (Vol II) p.28.

[119] Ev. (Vol II), p.131.

[120] *Ibid.*

[121] Ev. (Vol II), p.28.

[122] Q198.

59. We were pleased to learn that DTI had recently agreed that certain information would be made available to BGS which would give BGS the option of contacting the owner and applying for copies of the data. However, this is a limited concession.[123] **While we appreciate the DTI's concerns about confidentiality, we believe the current situation is not satisfactory, and a higher priority should be given to maintaining the role of the NGIS as the national depository of geological information, especially since this could probably be done without significant costs. Once the period in which borehole data supplied to the DTI is confidential has passed, there should be a presumption that the NGIS should receive any data it can use. Currently seismic data has no release date; this should be re-examined. The DTI, NERC and the BGS should consult one another before the next contracts are let to ensure that there is clear agreement over the NGIS's needs, and that the contracts ensure that data is kept in a form which the NGIS can subsequently use and is transmitted to NGIS once it is no longer confidential. Other government departments may also need to be alert to the need to ensure that data they hold is made available to the appropriate data centre.**

60. It may be that, in turn, the DTI will need assurances over the BGS's activities as a competitor in oil and gas consultancy. The IPMS said that NERC centres

> "hold large amounts of data donated on a voluntary basis by industry and local and national organisations. It is likely that should NERC begin to compete with its current customers in their areas of work this voluntary donation of data will cease and such environmental data may be lost from industry and the public."[124]

We do not believe the BGS will need to withdraw from consultancy, but the Survey, and those who fund it, should be alert to such dangers. Encouraging BGS to act as a commercial consultant may benefit both the companies which can buy access to its expertise and the Survey itself, but this should not be at the expense of the Survey's main role.

61. There may be an associated problem in the way in which departments let tenders for scientific services. It is government policy that departments should open the services they require to competition and the BGS has won several contracts to provide services to other government departments. However, tendering has its own costs — it is possible that up to 20% of a contract may be spent on the process itself.[125] Moreover, we were told that government departments had an increasing tendency to break work into small contracts, which increased the costs associated with the tendering process. The Director of the BGS, Dr Peter Cook, told us that industry did not go out to tender with the same degree of zeal as government departments; they realised that it was more important to "develop a long-term relationship" and that they understood "the science, they talk to us about our cost, then they acknowledge we need 10 per cent or 20 per cent on top of that, and then they will agree we are the best people to do that."[126] **It is for the company seeking the business to judge whether it is worthwhile to compete for a particular tender. In this, the BGS is no different from any other contractor, and it should be prepared to be selective in its activities. Departments should also be aware that if this happens they will lose access to the BGS's expertise and this may prove irreplaceable.**

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[123]Ev. (Vol II) p.28.
[124]Ev. (Vol II), p.126.
[125]Q180.
[126]Q181.

Conclusion

62. In the course of our inquiry we have been very impressed by the global environment research carried on in the United Kingdom, and by the way in which this research was related to European and world wide research programmes. We were delighted to confirm that in this field, as in others we have examined,[127] United Kingdom scientists are at the forefront of research. We are also heartened to note that the Department of the Environment is alert to the policy implications of this research, and is urging other departments to take the implications of climate change into account in their policy making. However, we have also identified a number of factors which may prevent this good record continuing.

—*The co-ordination of research into global environmental change*; although this is the most pressing problem, it is under active consideration, and we trust will soon be resolved in a way which ensures that Chief Scientists and the Heads of Research Councils are involved considering the United Kingdom's contribution to this research.

—*The way in which departmental policies may inadvertently damage the science base*; this could in many cases be solved without forsaking the policy itself, as long as the importance of science was recognised.

—*The extent to which constraints on spending throughout the public sector may result in pressure on the Science Budget*; this pressure will not necessarily result from reductions in the budget itself, but from the transfer of responsibilities or the reduction in funding from other government departments. This is the problem which may be gravest in the long term. We have seen two examples of it in the treatment of attribution, and the new funding regime for the C-130.

Sir John Houghton was concerned that the United Kingdom "does not have a lead department which has taken responsibility"[128] for research into global environmental change. The solution to the problems we have identified does not require centralisation of responsibility into one department. However, it does need strong leadership from the successor to the IACGEC, and, still more importantly, from the OST, in working to ensure that all government departments remain aware of the importance of this science base to the nation, and their role in maintaining its excellence.

[127]Third Report from the Science and Technology Committee, Session 1995-96, *Human Genetics: The Science and Its Consequences*, HC 41-I and the Fourth Report from the Science and Technology Committee, Session 1995-96, *The Particle Physics and Astronomy Research Council*, HC 249-I.

[128]Q137.

LIST OF TERMS AND ABBREVIATIONS

BGS	-	British Geological Survey
BNSC	-	British National Space Centre
CCLRC	-	Council for the Central Laboratory of the Research Councils
CERN	-	European Organisation for Nuclear Research
DOE	-	Department of the Environment
DTI	-	Department of Trade and Industry
EPSRC	-	Engineering and Physical Sciences Research Council
ESA	-	European Space Agency
IACGEC	-	Inter-Agency Committee on Global Environmental Change
IOC	-	International Council of Science Unions
IPCC	-	Intergovernmental Panel on Climate Change
NERC	-	Natural Environment Research Council
NGIS	-	National Geosciences Information Service
MOD	-	Ministry of Defence
OST	-	Office of Science and Technology
POST	-	Parliamentary Office of Science and Technology
PPARC	-	Particle Physics and Astronomy Research Council
UNESCO	-	United Nations Educational, Scientific and Cultural Organisation
WMO	-	World Meteorological Organisation

ANNEX

Note of the visit to Southampton Oceanography Centre, 8th July 1996

Professor John Shepherd, Director

(i) The Director explained that the Centre was a joint venture between NERC and the University of Southampton. The budgeted cost of the building was £49 million and this was funded by the NERC (c75%) and the HEFCE (c.25%). Each had been provided with extra resources for this. Running costs were divided 58% to the NERC Divisions and 42% to the University Departments. The building had 22,500 sq m of space (gross) and had a design life of 125 years. It contained a large lecture theatre, 150 laboratories and the National Oceanographic Library.

(ii) The Department of Oceanography and the Department of Geology of the University of Southampton were based here. A range of undergraduate degrees were offered which included some teaching time at SOC. Third year students and research post graduates spent all their time at SOC. NERC activities in the Centre had come from the Institute of Oceanographic Sciences Deacon Laboratory, the James Rennel Centre for Ocean Circulation, and Research Vessel Services (which ran RRS Challenger, Discovery and Charles Darwin, which had previously been based at Barry in South Wales). The University managed RVS but had no control over the programmes of research cruises.

(iii) The Centre had about 500 research and engineering staff; including 150 postgraduate students, mostly from Southampton but also some from other universities; and 450 undergraduates studying a range of degree subjects including Oceanography, Geology, Marine Geology, Geophysics and combined multi-disciplinary subjects including engineering. The Centre covered a broad range of disciplines catering for "students to seamen." While NERC had a "deep sea focus" the University's range of interests was far wider; for example, the Department of Geology studied terrestrial as well as deep sea geology, and the Department of Oceanography included coastal and estuarine studies.

(iv) The Centre's mission was teaching; research; and technology transfer - "to understand the earth and its ocean as a system, on a global scale, if necessary" (as well as research vessel operations). It worked closely with the Hadley Centre and the Met Office, on atmosphere/ocean interchange research/monitoring. In answer to a question from Dr Bray, Professor Shepherd explained that national and international projects were closely related. Partnerships between scientists were often the driving force behind collaboration rather than inter-governmental agreements; they sought funding from their national programmes for such research. This meant that there was less scope for inefficiency than in a centralised programme, but a lot of "legwork" in co-ordinating the different national programmes.

(v) The next major oceanic observation being mooted was "GOOS" the Global Ocean Observing System; this would be operational, although it relied on premises research and would produce results for future research and there was no agreement for funding it as yet. Professor Shepherd supported GOOS (the "Eurogoos" office was at the SOC) but thought more work needed to be done on the operational details.

(vi) The Director said that the Centre studied all aspects of ocean circulation from seasonal variations to changes which had taken place over millennia. Oceanography

was a multi-disciplinary subject requiring chemistry, biology, geology and physics together. The SOC pushed forward interdisciplinary studies.
Some examples of SOC's work were:

—the World Ocean Circulation Experiment, which was now progressing from the observation to the analysis phase;

—the Ocean Drilling programme; by drilling "in the right places" it was possible to record the oceans' changing "climate";

—Professor Shepherd had chaired the group set up by Tim Eggar to examine the Brent Spar disposal issue;

—Carbon Dioxide disposal in the deep ocean: an IEA workshop had recently been held at the SOC, but there was no funding for research in the UK at present;

—Disaster prediction - tidal waves resulting from under ocean earthquakes etc;

—Instrumentation development - TOBI (Towed Ocean Bottom Instrument) can carry other high technology instrumentation and be "flown" close to the bottom of the ocean, and Autosub, which had recently completed its first trials satisfactorily.

(vii) While the Director did not think deep sea mining would be introduced soon, it was becoming more likely; SOC would be able to advise companies on their methods, and advise governments on the necessary environmental controls.

(viii) The NERC Research Vessels were chartered to other organisations commercially when there was spare capacity but about 80% of time at sea was for scientific investigation. There was an average of 75% utilisation of the vessels although RRS Discovery had been laid up for 6 months recently. The Director explained that funding for scientific projects was peer reviewed before funding was granted for use of the vessels. The Research Cruises Co-ordinating Group consisting of user representatives and RVS management coordinated the use of the ships. The costs of the vessels was divided into

"Infrastructure" - the cost of owning and maintaining the fleet, carried by NERC; and

"Superstructure" - the cost of programmes run on the vessels, charged to researchers.

The true marginal cost between the ship being used at sea and it doing nothing was lower than the superstructure costs.

(ix) In answer to a question from Dr Bray the Director said that there was no funding stream for lower level research to "fill the gaps" in the use of the ships. RRS Discovery had a refit 3 years ago and had now an estimated life of 15 years. It was one of the best research vessels in the world. Operation of the research Vessels had been market tested and the in-house team had won.

(x) Exploration of the deep ocean was difficult and in effect was an exercise in remote sensing (one of the key technologies identified in Foresight) but mainly using instruments and vehicles in the sea rather than satellites. The UK did not have any manned underwater vessels and made use of US, French or Russian ones. The Centre was developing Autosub I to be used remotely with a range of up to 120km. There was expectation that this range could be improved in the next few years but this would depend on developments in battery technology. The use of satellites allowed

almost realtime coverage but this was only of the surface "skin" of the ocean. The centre had developed a number of instruments and vehicles including a nitrate sensor which were licensed to companies for marketing.

(xi) Artificial reefs were being developed and studied; Shell were interested in these as possible alternatives for Brent Spar's disposal.

(xii) In answer to a question from Sir Trevor Skeet, the Director said that industry might have the technical capacity to develop the instruments required by NERC but the potential market was too small for it to be worth companies' while; NERC did work very closely with the main equipment manufacturers. In France and Germany and, to an even greater extent, the USA, Government funded nearly all of this type of research. The Centre already had strong links with other groups worldwide, and exploratory talks were taking place with Centres in China (Qingdao), Brazil, Taiwan and elsewhere.

Tour of the Centre

Professor Paul Tyler, Teaching and its benefits for Oceanographic Research at SOC

(xiii) Professor Tyler told the Committee that in the first two years students spent part of their time at SOC; in the 3rd year they spent all of their time there and all students did a project, which could be supported by people in research divisions.
He knew of nowhere else where teaching and research were so intimately linked. Moving students to the SOC in this way exposed them to strategic research and industrial applications. SOC also ran a Masters degree to help students from other disciplines convert to oceanography.

Mr Keith Birch, Ocean Technology Division

(xiv) Mr Birch told the Committee the division invented novel equipment not available elsewhere; NERC bought "off the shelf" technology if it existed. The division employed about 40 people, and included representatives of all engineering disciplines apart from civil engineering. It could work for universities, NERC or for industry. Only 20 per cent of the division's funds were ring fenced (for the Autosub), the rest had to be won through contracts.

(xv) He described a project partly funded by the oil companies to conduct an environmental survey of the ocean bed off Shetland to determine the potential effects of drilling. For oil exploration the DTI required this type of survey to be conducted, but not to the same level of detail as the one that was being done. TOBI was used to do this and had just completed a 13.5 day continuous deployment without service. Funding for this survey was mainly from a consortium of 14 oil companies - the Atlantic Frontier Environmental Network, together with a smaller contribution from NERC. The data obtained will form the basis of NERC and EPSRC 'follow on' programmes, in the order of £5m in subsequent years.

(xvi) Mr Birch showed the Committee the autonomous underwater vehicle (AUV), the Autosub - 1. He explained the novel value of the programme in developing a "proven robust and reliable" vehicle and associated sub-systems. Wherever appropriate commercial components were used to save on development costs.

Professor Norman Hamilton

Professor Hamilton showed the Committee the main teaching laboratory which could seat 150 students and be used for experiments by 120 simultaneously. Geologists worked all round the world, including the Falklands, Greenland and China. They were interested in both terrestrial and marine geology, including:

—the chemistry of rocks;

—active hydro-thermal vents on the ocean floor;

—studies of fractures in rocks for NIREX as part of its investigation into a deep repository for nuclear waste;

—the international Ocean Drilling Programme for which the UK pays an annual subscription of £2m, which gave it access to some £30m worth of research.

Dr Bob Whitmarsh, Challenger Division for Seafloor Resources

(xvii) Dr Whitmarsh talked to the Committee about the "management and exploitation of the seabed and its resources". The deep sea floor made up 60% of the worlds surface. The Division studied:

Mid Ocean Ridges; including hydrothermal vents, and the creation of oceanic crust.

Continental Margins: The hydro-carbon industry was interested in the potential of this area, and there was some defence interest

Ocean Basins; cable and pipeline routes had to be worked out; results might also be useful for studies related to waste disposal

Regions of instability - underwater avalanches could cause tsunami (tidal waves); plate boundaries under the ocean floor could be the sites of earth quakes and volcanoes;

Geological and biological processes on the sea bed.

The division had five main projects

—the biology of the sea floor (obtained a significant proportion of funding from EC)

—Managing Impacts on the Marine Environment (funded by EPSRC, NERC and industry)

—continental margin sediments (again, some EC funding)

—chemical changes and climatic fluctuations (again, some EC funding)

—active seafloor spreading processes (supported by the NERC BRIDGE programme which ended the following year).

(xviii) Dr Whitmarsh said that as a result of the thematic funding of projects by NERC the days had gone when an individual scientist could get funding for a unique project. No geoscience cruise that was not in such a thematic project had been funded. The division obtained 42 per cent of its funds from NERC; 27 per cent was baseline funding, the rest had to be competed for.

(xix) The UK were very successful at getting EC funding for this type of research, but this would cover only 50 per cent of costs. MOD was the main Government funder; funding from the DTI was decreasing. Industry would rarely fund strategic research. There was a growing tendency for funding to come from short term and unreliable sources which was not conducive to long term strategic research.

Dr John Gould/Mr Trevor Guymer, The World Ocean Circulation Experiment

(xx) Dr Gould and then Mr Guymer spoke about the World Ocean Circulation Experiment (WOCE). Its aim was to develop improved ocean models for climate research and to collect the data sets necessary to test them. It was part of the world programme into climate research, in which the International Panel on Climate Change had been a driving force.

(xxi) Planning had started in 1983 when there was the first prospect of Earth Observation satellites able to look at the ocean surface and of computers powerful enough to model the eddies involved. The timetable was:

1984	UK hosted International Project Office
1990	Observations started
1991	Satellites launched
1992	Satellites launched
1993	Satellites launched
1997	End of observations
until 2002	Data analysis.

(xxii) Analysis, interpretation of results and computer modelling would continue until 2002. The experiment examined the circulation of heat in the ocean; 50% of the heat of the atmosphere was held in the ocean and analysis of the transportation of this heat provided valuable information about the world's weather. This was a very large global experiment which required a long term commitment by the 25 countries involved.

(xxiii) WOCE ship based observations are made from sensors lowered to the sea bed to measure temperature, salinity and to collect samples for analysis of many chemical constituents. One, CFCs, can be used to determine the time since water was last in contact with the atmosphere. This is a key factor in assessing the oceans' ability to transport heat, and to sequester carbon dioxide. UK scientists have made observations in all the oceans and have used British Antartic Survey ships to make repeated obervations of the biggest ocean current in the Drake Passage between South America and Antarctica. The UK is at the forefront of ocean modelling.

Mr Paul Stone

(xxiv) Mr Stone spoke to the Committee about the Research Vessel Services. Challenger, Discovery and Charles Darwin were all multi-role vessels. The total cost of operating the vessels was £8m per year. Discovery had been laid up for 6 months (from December 1995 until June 1996). In the past the vessels were in constant use and universities had funded their own cruises which had included undergraduates in the 1970s. Although some universities still bought time directly this was less common. The project based funding system meant that this although undergraduates could use spare capacity in principal, this was at the discretion of the principle researcher and rarely, if ever, occurred.

(xxv) If the ships had to be laid up, RVS sought a cost-effective berth; Southampton charged full port dues even though SOC had leased the quay for 125 years.

Mr Howard Roe, George Deacon Division for Ocean Processes

(xxvi) Mr Roe explained that his aim was to understand how the ocean works in total. His division concentrated on research on how the physical world interacts with the biological world. "You cannot rationally predict the sea if you cannot understand it". The division had four primary objectives:

—to describe and quantify what was going on in the ocean;

—to develop new instrumentation (eg acoustic sensors to complement sampling using nets);

—to develop coupled biological/physical models especially of processes affecting planktonic plants and animals;

—to quantify fluxes for properties between the ocean surface and the atmosphere.

It conducted research world wide.

PROCEEDINGS OF THE COMMITTEE RELATING TO THE REPORT

WEDNESDAY, 12 MARCH 1997

Members present:

Sir Giles Shaw, in the Chair

Mr Spencer Batiste	Mr Andrew Miller
Dr Jeremy Bray	Sir Trevor Skeet
Mrs Anne Campbell	Mr Patrick Thompson
Dr Lynne Jones	Sir Gerard Vaughan

The Committee deliberated.

Draft Report (The Natural Environment Research Council and Research Into Climate Change), proposed by the Chairman, brought up and read.

Paragraphs 1 to 62 read and agreed to.

Annex agreed to.

Resolved, That the Report be the Third Report of the Committee to the House.

Ordered, That the Chairman do make the Report to the House.

Several papers were ordered to be appended to the Minutes of Evidence.

Ordered, That the Appendices to the Minutes of Evidence taken before the Committee be reported to the House. — (*The Chairman.*)

Several Memoranda were ordered to be reported to the House.

[Adjourned till Tuesday 18th March at Eleven o'clock.

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Memoranda from:

UNPRINTED MEMORANDA

Additional memoranda have been received from the following and have been reported to the House, but to save printing costs they have not been printed and copies have been placed in the House of Commons Library where they may be inspected by Members. Other copies are in the Record Office, House of Lords, and are available to the public for inspection. Requests for inspection should be addressed to the Record Office, House of Lords, London, SW1. (Tel 071-219 3074). Hours of inspection are from 9.30 am to 5.30 pm on Mondays to Fridays.

R F P Hardman, Exploration Business, Amerada Hess Limited (HEE 35)

M Bittleston, The Met Office (NEE 39)

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